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GB-58 AND GT-58 GAS-GENERATOR TRACTORS

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NATI

[Tables and figures referred to are appended.]

The Soviet Union possesses enormous power resources. Almost every oblast has local reserves of fuel in the form of coal, peat, or wood. The utilization of these types of fuel as a substitute for petroleum products is an important task in the national economy.

Until recently, wooden logs have served as fuel for gas-generator tractors. This restricted their use to regions which are rich in wood. In addition, the motors of gas-generator tractors developed approximately 13-15 percent less power than motors of the same displacement operated on liquid fuel. This lowered tractor productivity from 20 to 30 percent.

Two tractors have been built by the Division of Gas-Generator Tractors of NATI (State Union Scientific Research and Experimental Automobile and Tractor Institute) and by the Special Design Bureau of the Stalingrad Tractor Plant, based on the DT-54 tractor. They are the GB-58, operating on bituminous fuels, and the GT-58, which uses low-grade fuels.

To obtain the same tractive power as the DT-54, it was necessary to reduce power losses of the motor to a minimum. Displacement cannot be increased in this case since it would be necessary to redesign a number of parts of the connecting rod-piston group of the D-54 motor. Supercharging would be impractical because of the necessity of installing a complex unit, the supercharger blower.

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To decrease power losses, improvements were made in feeding the cylinders and the operating process, and the revolutions [per minute] of the motor were increased.

These measures assured constant power output of the G-58 motor (50 horsepower), working on generator gas from wooden logs. The output of the new motor is 7.4 percent less than the output of a D-54 motor; when using gas from other fuels, it is possible to develop an equal or even a greater horsepower. Table 1 shows comparative data for tractor motors operating on gas generated from wooden logs.

To compensate for the losses in tractive power, the speed of the tractor motor had to be reduced by 6 percent by changing the gear ratio of the main transmission from 2.56 to 2.93. As a result, the tractive power at the drawbar of a GB-58 tractor is almost the same as the tractive power of the DT-54 (Table 2).

The layout of the gas-generating unit of the GB-58 tractor is given in Figure 1. The layout of a GT-58 tractor differs only in its gas generator (which is shown in Figure 4). The units have almost completely standardized systems for filtering and cooling gas.

Logs of hard and soft varieties of wood and semicoke serve as fuel for the GB-58 tractor. For the gasification of this fuel, a gas generator has been developed which operates by the return process of gasification, using the heat of the generator gas for preheating the fuel in the hopper. The vibrating fire grate and opening for fuel are mounted in the gasification chamber.

Charcoal from hard and soft varieties of wood and semicoke are used for fuel in the GT-58 tractor. These fuels are gasified in a direct process generator with an air-steam blast.

The assemblies for filtering and cooling gas of both tractors differ only in the volume of the dust collectors of the coarse filters (cyclone dust extractors).

For the coarse filtration of gas, a new type of dust extractor is used, the NIOGAZ-NATI, which has a higher coefficient of cleaning than cyclone dust extractors formerly used in ChTZ-SG65 and KhTZ-T2G tractors. One cyclone dust extractor of the NIOGAZ-NATI type extracts 85-90 percent of the dust passing through it, while two dust extractors of the KhTZ-T2G tractor extracts only 50-65 percent of the dust.

The radiator-type gas cooler differs slightly from the cooler of the KhTZ-T2G tractor. A smaller dust content in the gas passing through the cooler in the new tractors made it possible to make that assembly four way. The cooler is welded, the cores cannot by removed from the tanks, and there is increased cooling surface. A filter which works on the principle of deep bubbling is used for cleaning the gas. The top of the filter is fitted with a checkerwork grill of metal rings. A circular hollow is made in the bottom for warming the bubbling liquid by the heat of the incoming gas. Preheating the bubbling liquid is necessary to prevent its freezing in winter.

The bubbling liquid is usually water. This causes the water in the filter to evaporate during the gasification of dry fuels and it is necessary to refill it regularly. Since semicoke, charcoal, and peat briquettes are just such fuels, it was decided to use used crankcase oil for the bubbling liquid.

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As the investigations showed, the use of oil improves the cleaning of gas and protects the metal rings from corrosion.

A PD-10 motor installed on the gas-generator tractors starts the motor and also kindles the fuel in the gas generator. A centrifugal kindling fan is connected to the reducing gear of the PD-10 for this purpose.

In Figure 2 is shown the arrangement of the assemblies of the gas-generating unit of the GB-58 tractor (the assemblies of the gas-generating unit of the GT-58 tractor are similarly arranged).

Generator 1 is located behind the cab of the tractor on the left side. The gas generator is located to provide easy access to all units while in operation for servicing tasks, such as filling up the water, cleaning the ashpit, loading fuel, etc.

Cyclone dust extractor 2 is located on the left side of the cab and is directly attached to the gas-generator housing. From the dust extractor, along the left side of the tractor, a gas pipe leads to the cooler.

Gas cooler 3 is located in front of the water and oil radiators. From the lower tank of the cooler, along the right side of the tractor, a pipe goes to the filter.

Filter 4 is placed behind the cab on the right side; this is the main difference between the general grouping of GB-58 and GT-58 tractors and the grouping of the KhTZ-T2G tractor, where the filter is found between the cab and the motor. This location of the fine filter simplified its design.

The filter is connected with the mixer 5 by a gas pipe going along the right side of the tractor. Kindling fan 6 is connected with the gas pipe in front of the mixer. The exhaust outlet of the fan is brought outside. The assemblies of the gas-generating unit are connected with gas pipes 7.

The control lever of the vibrating fire grate of the gas generator for bituminous fuel is extended to the tractor cab. The support bracket 8 of the control lever is placed on the floor of the cab to the right of the clutch pedal lever.

Two vacuum gauges 9 are mounted on the instrument panel for controlling the changes in resistance of the gas generator and the filtering system. The gauges indicate the vacuum behind the gas generator and in front of the mixer. Readings of the vacuum gauge indicate when it is necessary to use the vibrating fire grate, especially while operating on peat briquettes. Variant readings of the vacuum gauge facilitate control of the filtration system.

For convenient servicing of the gas generator and filter from behind the tractor, a loading platform 10 is constructed on the frame of the gas generator.

Technical Specifications of Gas Generator Tractors Based on the DT-54

(Note: Only parameters which have been changed are indicated.)

	GB-58	GT-58
Dimensions (mm):		
Length	3,900	
Height	2,640	
Width	1,870	

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	GB-58	GT-58
Weight of fueled tractor (kg)	5,850	
Specific pressure on the ground (kg/sq cm)	0.47	
Speed (calculated, not taking skidding into account) (km/hr)		
First gear	3.38	
Second gear	4.37	
Third gear	5.11	
Fourth gear	5.92	
Fifth gear	7.43	
Reverse gear	2.26	
Engine	G-58	
Type motor	Gas, four cycle, with electric spark plug ignition of the mixture	
Horsepower at 1,400 rpm	50-52	53-57
Compression ratio	8.5	8.5
Ignition system	Magneto	
Fuel consumption per effective hp (kg/hr)	0.85-0.93 wood logs, 0.8-0.97 peat briquette	0.45-0.50 semicoke, 0.42-0.45 charcoal
Gas generator	Reverse process	Direct process
Hours of operation before it is necessary to add fuel to the hopper	1.0-1.5 wood logs, 3.0 peat briquette	2.5 semicoke, 1.2-1.5 charcoal
Coarse filter	Cyclone	
Cooler	Tube, with four compartments	
Fine filter	Deep bubbling, with checker-work grill of metal rings	

Fuel reserves are stored on the roof in a special bin. From the data of braking tests after 1,200 hours of work of the gas generators under winter conditions, using charcoal, peat briquettes, and wooden logs, the following efficiency ratings for gas power units of tractors were obtained: charcoal, 22.8; peat briquettes, 15.0; pine logs, 18.6; and birch logs, 18.5.

The necessity of supplying the motor with resin-free generated gas requires the use of bituminous fuels with a volatile content in the burning mass of 28 to 85 percent, a reverse process of gasification, and, in connection with this, a higher quality fuel.

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In transport gas generators the following forms of fuel with small volatile content are comparatively easy to gasify: charcoal, carboniferous semicoke, and anthracite.

Charcoal as a by-product of industry is obtained in considerable amounts in the wood chemical industry. It can also be obtained from the ends resulting from the bucking of wood in the lumber industry.

Owing to its low degree of density (180 kilograms per cubic meter), charcoal is not a readily transportable fuel and is therefore utilized in districts close to its production source. However, on being briquetted, its density is increased five times. Briquetting was performed with positive results by the Central Scientific Research Institute of Wood Chemistry.

Charcoal contains a negligible amount of ash, has no sulfur, and possesses a high reactive capacity. Specific consumption for one horsepower hour does not exceed 450 grams. A ton of charcoal costs 100 rubles. Operating a GT-58 tractor with a productivity of 0.65 hectare per hour, charcoal cost per hectare is 3.5 rubles. For 1,000 hours of operation a year, 20-23 tons of charcoal are consumed.

Semicoke is also a by-product of industry: its character depends on the quality of the coked coal. Zhurinskiy semicoke is distinguished by a low content of ash, sulfur, and volatiles.

Washing of semicoke at the supplying factory reduces the ash content of the dry bulk from 5 to 6 percent. The bulk weight of semicoke is 450-550 kilograms per cubic meter, depending on its moisture content. The sale price of semicoke is 100 rubles a ton. The hourly consumption does not exceed 450 grams per horsepower.

The economy of tractor operation using semicoke and charcoal is the same, but the advantage of semicoke is its greater density. Semicoke requires less storage space and assures more continuous operation of the tractor without refueling the gas generator. This reduces from two to three times losses of time due to idleness of the tractor.

Anthracite was not used as a fuel for tractor generators, in spite of its lower cost. The difficulty of removing sulfur compounds (which induce corrosion) from gas generated from anthracite and the low melting temperature of the ash prevent the use of anthracite for tractor generators. In practice, it has been established that the total sulfur content in dry fuel for tractors must not exceed one percent and ash content must not exceed 7 percent. Anthracite brands AP, AK, and, in some cases, AM, have such an ash content.

Before using anthracite as tractor fuel it is necessary to break it down to a size of 6-13 millimeters. The crushing is quite easily performed in jaw crushers used to crush rocks. Such preparation can be accomplished on the MTS. The anthracite of many deposits meets the above specifications with regard to ash and sulfur content.

Peat briquettes are of the greatest interest to agriculture. The growing production of peat briquettes in the country during the postwar period portends a wide use of this form of fuel for tractor gas generators.

AG Gas Generator

The AG gas generator, designed for the gasification of dry wooden logs and peat briquettes, operates on the reverse gasification process, utilizing the heat of the generator gas to heat the fuel in the hopper.

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In its general layout, it does not differ from the ordinary tractor and truck gas generators. However, a number of innovations in design make it possible to use various bituminous fuels with volatile contents from 28 to 85 percent. A diagram of the AG gas generator is presented in Figure 3. In the gasification chamber, interchangeable openings of two types are used for the gasification of wooden logs and peat briquettes respectively, and the attachment of the chamber to the housing of the gas generator is changed. A movable fire grate, with a special shape for each of the forms of fuel, is used.

The walls of the housing in the zone radiating heat from the chamber are shielded. Two accessory hatches with threaded lids have been added. The shut-off arrangement of the loading hatch has been changed. The dimensions of the gas generator are enlarged to create a greater reserve of fuel in the hopper and to reduce the resistance to the passage of gas around the chamber during the gasification of peat briquettes.

The combination welded gasification chamber consists of an overhead cast flange with a cylinder welded to it. A supporting ring with a groove, the opening of which is hermetically sealed, is mounted on pins welded to the cylinder. The supporting ring has a supplementary circular groove and slots in the lower collar which permit it to slide on the pins. The ring turns 22.5 degrees during mounting.

To create a hermetic seal and an outlet for heat from the opening, the groove of the supporting ring and the circular space between it and the cylinder of the chamber is filled with fire clay and a sodium silicate solution.

Openings of various sizes and shapes are used: for wooden logs, a diameter of 150 millimeters with a small angle of taper; for peat briquettes, a diameter of 175 millimeters with a large angle of taper.

Lengthening the life of the chamber is attained by aluminizing it by the new high-speed method introduced by Gorodnoviy of Orgavtoprom (All-Union Institute of Automobile Technology).

The introduction of a supporting ring permits setting the opening the exact height above the tuyere flange and also permits motion of the connection at temperatures distorting the cylinder of the chamber, while sealing with fire clay prevents the penetration of resinous gases along the periphery of the chamber. Herein lies the advantage of the new type of chamber. The supporting ring serves as a straightening device when the chamber is cooled and provides for the retention of the cylindrical shape of its housing.

A removable opening was previously installed in the chambers of NATI G69-I and OIA gas generators. The state tests revealed good properties in the new modification described. Distortion of the walls of the cylinder of the gasification chamber during operation on peat briquettes does not exceed 5 millimeters after 1,200 hours of operation.

In KhTZ-T2G and ChTZ-SG65 tractor gas generators, the fire grates are stationary, making it necessary to clean the grate, which meant opening the cinder hatch, making the work of the tractor driver difficult.

The life of the fire grate did not exceed 500-600 hours. In the AG gas generator, there are a central vibrating fire grate and accessory stationary grates which form an ashpit in the bottom of the gas generator. A flat vibrating fire grate is used for wooden logs. A roof-shaped one is used for peat briquettes. It has three stoking projections. The vibrating fire grate is controlled from the tractor cab. The movable grate is used to break up the layer of peat coke in the gasification chamber, since the peat coke packs firmly and increases the resistance to the passage of gas after lengthy operation.

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During the gasification of peat briquettes, the layer of peat coke must be stirred periodically every 20-30 minutes. Under this condition, peat coke with an ash content of 50-60 percent is discarded into the ashpit.

The considerable heat of the walls of the housing, resulting from the radiation of heat by the red-hot walls of the chamber and from local heating of the housing caused by irregular movement of gas around the chamber, made it necessary to shield the walls of the housing. The shield consists of eight separate sections suspended from claws welded to the housing. The lower edges of the sections of the shield prevent the side grates from falling. The life of the sections exceeds 1,200 hours.

Technical Specifications of the AG Gas Generator

Diameter of the housing (mm)	650
Over-all height (mm)	1,680
Diameter of the hopper (mm)	600
Consumption capacity of the hopper (liters)	220
Storage capacity for continuous operation (kilograms)	
Hard varieties of wooden logs	70
Soft varieties of wooden logs	55
Peat briquettes	120
Diameter of the chamber (mm)	350
Number of tuyeres	10
Diameter of the tuyeres (mm)	12
Height of the active layer (mm)	270
Space between the chamber and grate (mm)	80
Diameter of the opening (mm)	
For wooden logs	150
For peat briquettes	175
Capacity of the ashpit (liters)	50
Weight of the gas generator (kilograms)	270
Intensity of combustion in the tuyere zone (kcal/sq m/hr)	
With wooden logs	1.9×10^6
With peat briquettes	2.009×10^6
Specific velocity of air in the tuyeres (meters/sec)	15.6
Consumption of gas at full load of the motor (cu m/hr)	92

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Stand tests were made of the AG gas generator by NATI, using a flat grate and peat briquettes from the Tootsinskiy Plant in the Estonian SSR. The peat briquettes had an ash content in dry volume of 4.9 percent; the moisture content of the working fuel was 14.9 percent; the content of volatiles in the combustible mass was 72.4 percent. The results of the stand tests were as follows:

Power of the GD-50 (it differs from the G-58 in having the camshaft of an IMA motor), average for 20 hours (according to GOST 491-41) (hp)	54.1
Consumption of peat briquettes (kg/hr)	36.6
Temperature of gas on leaving the gas generator (average) (deg C)	316
Vacuum of gas on leaving the gas generator (average) (meters of water column)	262
Temperature of gas on leaving the gasification chamber (average) (deg C)	612
Temperature of the walls of the housing (deg C)	300
Resistance of the air belt (average) (millimeters of water column)	73
Resistance of the layer of fuel (average) (millimeters of water column)	140

The wastes of the ash of peat coke amounted to 3.8 percent of the weight of the briquette. The ash content of the waste products was 43-67 percent, averaging 52.5 percent. Loading of the gas generator took place every 3 hours. The vacuum behind the gas generator did not exceed 300-400 millimeters of water column. With an increase in the vacuum, the layer was stirred by means of the moving grate. The thermal efficiency of the gas generator was 75 percent.

Tests of a gas generator using wooden logs and peat briquettes were conducted by a joint commission at the Stalingrad Tractor Plant (Table 3).

At the stand tests, a high specific consumption of peat briquettes was noted. During the operational tests of a tractor with a load of 80-90 percent, it consisted, on an average for 1,000 hours of work, of 41 kilograms per hour. A gas generator was also tested with the fuel opening diameter increased to 270 millimeters, using brown Sulyuktinskiy coal. The tests revealed that the average output of a motor for 10 hours of operation was 46.6 horsepower. The period of operation of the gas generator on brown coal without cleaning the chamber did not exceed 10 hours, because of the accumulation of a large quantity of slag.

Gas-generator tests were made on lump peat. The average output of the GP-50 motor in the course of 20 hours was 42 horsepower. The gas generator worked steadily on lump peat. A decrease in the heat value of the gas was caused by the high moisture content of the peat.

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The best results are attained with the gasification of peat briquettes.

BG Gas Generator

The BG gas generator for the gasification of charcoal, semicoke, and anthracite operates on a direct process, with an exhaust draft and gas take-off in the middle of the layer for the decomposition of pitch. The direct process, with gas take-off in the middle of the layer, was selected with the aim of obtaining a gas with a high calorific value. As the tests showed, pitch was decomposed with a volatile content in the charcoal up to 40 percent.

Coal gas generators with a horizontal gasification process, as shown by NAMI (All-Union Scientific Research Automobile and Automobile Motor Institute) experiments in 1939 - 1940, yield a gas with a lower heat value, have more thermal losses, and cause considerable wear due to dust.

In NATI tests of the KhTZ-T2G type tractor with a G-32 gas generator, the output of the D2G motor was 38 horsepower at 1,250 revolutions per minute. A diagram of the BG gas generator is shown in Figure 4.

With a direct gasification process, an efficient counterflow of fuel and gas is realized. Air mixed with steam is directed into the gas-generator shaft from below, while the gas being formed rises to meet the descending fuel. At a fixed height of the layer of fuel, at which decomposition of pitch and of the completion of the reduction process have taken place, gas is drawn out of the gas generator and into the filtration system.

The height of the active layer in the gas generator depends on the reactive capacity and sizes of the pieces of fuel. When fixing the height of the gas take-off, in case of operating the gas generator without removing the slag, the ash content of the fuel and the designated time that the gas generator must operate without being cleaned must also be taken into consideration.

The gas generator uses two heights of the layer of fuel in the active zone: for the gasification of charcoal, 375 millimeters; for semicoke and anthracite, 525 millimeters. This is done by changing the gas take-off pipe.

With semicoke with an ash content from 5 to 6 percent, and with a full load, the height of the operating layer (according to the NATI data) decreases to 370 millimeters in the course of 17-18 hours. When this happens, there is no deterioration in the quality of gas nor reduction in the output of the motor. A further decrease in the layer leads to a diminished calorific power of the gas and an increase in its temperature as it leaves the gas generator.

The gas generator is equipped for periodic removal of slag and ash. To secure a uniform passage of the steam-air mixture into the shaft of the gas generator, the fire grate is shaken periodically.

The grating is two stage, with two groups of grates situated on rollers. The grates are mounted on two shafts and rest on the opposite shafts. The grate is controlled from outside.

Slag is removed from the chamber through the top side hatch.

As protection from gas flashes while loading the gas generator, a flash extinguisher is installed in the top of the hopper. Before refueling, air is supplied through it for combustion of the gas in the hopper, after which the loading is done safely. On loading the gas generator with charcoal after an hour's work, when a sufficient amount of coals are present in the hopper, it is possible to refuel without using the flash extinguisher.

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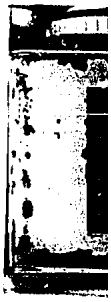

The apparatus for generating steam is located on the gas generator, which shortens the length of the water pipes and permits operation with the heating of the external water pipe in winter.

The steam-water conducting system of the gas generator consists of a water tank 4, located around the hopper, a vaporizing jacket 12, encircling the gas generator; a steam superheater 9, under it; a floating water-level regulator 19, and components of the water filter.

Water entering the steam-generating chamber is cleansed of coarse mechanical impurities in the water tank by a double filter 24, a settling tank, and by a fine regulating filter in the steam generating chamber.

The ashpit of the gas generator is insulated with asbestos to protect it from the vapor condensing from the entering steam-air mixture in winter.

Generation of steam and preparation of the steam-air mixture takes place in the following manner. The steam formed in the vaporizing jacket during the boiling of water, heated by the hot walls of the shaft housing, enters the steam superheater 9, goes through a metering diaphragm 8, and comes out into the steam air-mixture pipe connected with the cinder pit. Preheating of vapor takes place at atmospheric pressure; the temperature of the vapor reaches 270 degrees. On raising the pressure in the superheater, the vapor goes through a pipe installed in the superheater into the surrounding atmosphere. Before combining with the vapor, air is heated in the dust-extractor housing, where it goes out a pipe into a ring-shaped chamber, located on the shaft housing, above the steam superheater. The temperature of the heated air before combining reaches 150-170 degrees. The steam-air mixture entering under the fire grate has a temperature of 130-170 degrees.

The amount of vaporizing water in the steam-generating jacket is regulated by a floating control. The height of the water level determines its heating surface. The admission of excess vaporized water is controlled by a stopcock.

In order to reduce the heat, the wall of the /furnace/ shaft housing is insulated to the height of the water level in the steam-generating jacket.

In the gasification of charcoal, the temperature of the gases around the walls of the housing at a height of 75 millimeters from the fire grate is 900-1,050 degrees; therefore, a ring-shaped metal covering coated with aluminum is used for insulation. The space between the covering and the housing of the /furnace/ shaft is filled with a heat-conducting material.

For the gasification of semicoke, ceramic insulation is used, since the temperature of the gases reaches 1,270 degrees. It was experimentally determined that with a coefficient of heat conductivity of ceramics of 2.4-2.6 kilocalories per meter square per hour, the height of the insulated material should be 125 millimeters. In the zone where the insulation is cooled by water, hardening of the slag was not observed, since the temperature of the inner surface (700-750 degrees) is lower than the melting temperature of the ashes of semicoke (1,090-1,190 degrees).

The heat intensity for the evaporation of an optimum amount of water for the gasification of semicoke at the rate of 8.5 kilograms an hour equaled 34,000 kilocalories per square meter per hour. The temperature of the insulated wall of the housing under these conditions was 109 degrees.

Technical Specifications of the BG Gas Generator

Diameter of the gas generator housing (inner) (mm)	510

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Height of the active layer (mm)	
On semicoke	525
On charcoal	375
Volume of the active zone (liters)	
For semicoke	95
For charcoal	65
Specific volume of the active zone (liters/hp hr)	
When N_e equals 57.0 horsepower on charcoal	1.14
When N_e equals 53.5 horsepower on semicoke	1.78
Rate of combustion (kg/sq m/hr)	
On semicoke	186
On charcoal	168
Gas take-off per square meter cross section (cu m/hr)	725
Volume of the hopper (liters)	
For semicoke	162
For charcoal	190
Consumption volume of the hopper (liters)	
On semicoke	140
On charcoal	170
Capacity of the water tank (liters)	77
Duration of work (hr)	
On semicoke	2.5
On charcoal	1.5
Water consumption (kg/hr)	
On semicoke	8.5
On charcoal	6.0
Over-all height of the gas generator (mm)	1,680
Over-all diameter (mm)	680
Weight of the gas generator (kg)	270

At the stand tests of a NATI gas generator, charcoal from the Syavskiy Wood-Chemical Combine was used; Zhurinskiy semicoke, washed by the supplying plant was also used.

The tests were carried out with a GD-50 motor and with the gas-filter system adopted for the GT-58 and GB-58 tractors. The average power output of the motor on gas (according to GOST 491-41) after refueling the hopper to capacity three times was 59.3 horsepower at 1,400 revolutions per minute. Results of the tests were as follows: consumption of charcoal (average), 24.8

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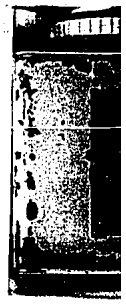

kilograms per hour; consumption of water (average), 6.2 kilograms per hour; vacuum behind the gas generator, 97 millimeters of water column; temperature of the steam-air mixture, 130 degrees Centigrade; temperature of the gas on leaving the gas generator, 430 degrees Centigrade. Reloading of fuel was necessary every 1.5 hours.

Tests of the G-58 motor with a gas generator using semicoke took place in the NATI laboratories from 17 to 23 hours without removing slag from the gas generator.

The following results were obtained in the tests:

Average power output (hp at 1,400 rpm)	53.5
Maximum power output (hp)	56.9
Power stability factor (percent)	1.69
Consumption of fuel (kg/hr)	24.2
Specific consumption of fuel (kg/hp hr)	0.45
Average consumption of water (kg/hr)	9
Vacuum behind the gas generator (millimeters of water column)	144
Temperature of the steam-air mixture (deg C)	150-170
Temperature of the gas on leaving the gas generator (deg C)	430-470

Gas obtained from semicoke had the following composition by volume: 27.5 percent CO, 15.3 percent H_2, 1.1 percent CH_4, 4.7 percent CO_2, 0.3 percent O_2, and 51.2 percent N_2. Its heating value was 1,328 kilocalories per nominal cubic meter.

Tests of the gas generator were conducted for 7 hours with anthracite coal from No 22 mine of the Stalinugol' Combine of the Snezhnyantratsit Trust. In the tests, using this anthracite coal with an ash content of 2.46 percent and a water consumption of 59 percent that of fuel consumption, the power output of the GD-50 motor reached 52-54 horsepower.

In the tests, the consumption of anthracite was 21 kilograms per hour; consumption of water, 12.4 kilograms per hour; and specific consumption of fuel, 0.42 kilogram per horsepower hour.

G-58 Gas Motor

The G-58 gas motor is designed along the lines of the D-54 motor. Generator gas is used as fuel. During the development of the gas motor, it was necessary to obtain a power output of no less than 50 horsepower. Measures for attaining such a power output were taken on the basis of experience acquired from studying the gas motor of the KhTZ-T2G tractor.

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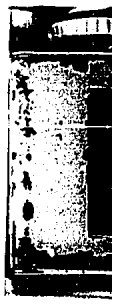

This motor, called the D-2G, was also constructed, just as the D-54 motor, on the basis of the IMA kerosene motor. At 1,250 revolutions per minute of the shaft, while operating on gas generated from birch logs, it developed an effective power output of 45 horsepower.

Tests of the motor showed that it possesses a considerable reserve of power, as shown by external characteristics. Its maximum power output is reached at 1,500-1,600 revolutions per minute. Lowering the temperature of the working mixture in the intake manifold by 10 degrees increases the power output of the motor by two horsepower; increasing the pressure of the mixture in the manifold to 100 millimeters of water column raises the power output by one horsepower.

On the basis of the data obtained, it was established that the power output of the planned G-58 motor could be increased further by increasing the number of revolutions per minute of the shaft, lowering the temperature of the gas-air mixture, and decreasing the intake resistance.

In addition, the adoption of a combustion chamber with a more compact form should improve the working process of the motor by shortening the combustion time of the working mixture and decreasing heat losses.

An increase in the power output of the gas motor also could be achieved by raising the compression ratio, but since this would cause difficulty in the selection of spark plugs, in the first version /of the G-58/ the compression ratio was set at 8.5.

In the development of the new motor, the following conditions were assumed: retention of the basic dimensions of the D-54 motor, securing the accepted power output without the use of supercharging, maximum utilization of the units and parts of the D-54 motor, starting the gas motor on generator gas, and operating the motor in a cycle of rapid combustion with ignition of the mixture by an electric spark. The motor shaft operated at 1,400 revolutions per minute. An increase over this number was inexpedient, since the gain in power is negligible and there was increased stress due to inertia.

In order to reduce preheating of the working mixture, the intake and exhaust manifolds were located on different sides of the motor. Longitudinal and cross sections of the motor are given in Figures 5 and 6.

On the right side of the motor there is an intake manifold, to the flange of which a mixer is attached. An M-6 magneto with a PU-4646 accelerator is installed which provides a high-voltage current. NM12-14AG type spark plugs are used. A PD-10 starting motor is retained to facilitate starting the gas motor and kindling fuel in the gas generator. The kindling fan is fastened to the reduction gear of the starter motor. The exhaust manifold and the governor are on the left side of the motor.

The head of the cylinder block differs from the cylinder head of the D-2G gas motor by the lesser dimensions of the oval combustion chamber (Figures 7 and 8) in view of the absence of starting valves and the arrangement of the intake passage on one side of the motor and the exhaust on the other side.

In order to increase the coefficient of /fuel/ admission, the cross section of the intake passages in the cylinder head was enlarged to 28 cubic centimeters (the D-2G motor has an opening of 24 cubic centimeters and the D-54, 20 cubic centimeters).

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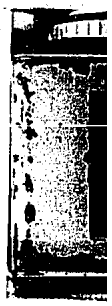

The front and rear ends of the block have rectangular openings; at the front one there is a pipe for carrying water from the water jacket of the block to the radiator. As in the diesel, there is a pipe in the rear which connects the water jacket of the gas motor's cylinder block with the water jacket of the starter motor.

On the left side of the cylinder block there are cast pockets with threaded openings 18 millimeters in diameter where spark plugs are screwed in. The height of the cylinder head is greater than that of the D-54, for which reason the valve push rods are lengthened. The cap of the cylinder head is changed; its cover is similar to that of the D-54 motor.

The pistons of the gas motor are of cast iron with flat heads and have four compression and two oil rings. The rest of the crankshaft-connecting-rod assembly is left unchanged.

The intake manifold is connected in pairs with the intake passages of both the first and second and the third and fourth cylinders. The exhaust manifold at first had three pipes; subsequently, in the final version, it had four. The cross section of the manifold for the whole length and at the inlet is 28 cubic centimeters.

Owing to the removal of the fuel pump and the introduction of a drive gear for the generator and governor, the timing gear housing and the cover of the housing were replaced by new ones. Drive gears are installed for driving the governor and the generator, which are analogous to the corresponding parts of the IMA kerosene motor.

An angle bracket of the IMA motor, attached to the timing gear housing is used for mounting the generator. The generator is coupled to the drive gear by means of a sleeve.

The diameter of the driving pulley of the G-50 generator installed on the gas generator tractor was changed in view of the higher number of revolutions [per minute] of the G-58 motor.

The governor, limiting maximum revolutions of the crankshaft, is basically the same as the governor of the IMA kerosene motor. Changes were necessitated by the increase in the number of revolutions per minute of the shaft. In connection with this, the spring of the tension device was changed. The working tension of the spring was increased to 22.5-24.5 kilograms (in the governor of the IMA motor the spring tension is 16.5-21 kilograms).

The convenience in making adjustments, the cap of the tension device was shifted to the left side of the governor, resulting in alterations of the housing and components of the governor. Variation in tension of the governor is 10 percent.

Quantitative and qualitative regulation of the gas-air mixture is provided for in the mixer. Adjustments of the mixer by butterfly valves is accomplished from the tractor operator's cab. The butterfly valve for the quantitative regulation of the gas-air mixture is also connected to the governor. Openings in the lower water tank of the radiator are enlarged, since gas inlets pass through them to the gas cooler. The oil radiator is retained on the motor.

The hand lever for turning the motor shaft is lengthened due to the mounting of the gas cooler in front of the radiator. Changes in the starting motor affected only the exhaust pipe. The latter differs from the D-54 motor in having a direct outlet through the upper covering of the hood since there is no need to preheat the mixture on starting. The driven shaft and the roof of

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the reduction gear were altered in the reduction gears of the starter motor. The driven shaft was lengthened and a drive gear was mounted on the end of it, meshing with the driven pinion of the blower shaft. The top of the reduction gear housing, in which the pinions of the kindling fan were located, was changed. The housing of the blower is attached to the top of the reduction gear housing.

The over-all gear ratio of the starter motor crankshaft to the kindling blower is 1.351. The shaft of the starter motor makes 3,500 revolutions per minute, while the blower rotates at 4,700 revolutions per minute. The maximum productivity of the blower at the indicated revolutions per minute is 210 cubic meters per hour. Kindling of the fuel in the gas generator requires 60-70 cubic meters of gas per hour owing to the loss of pressure in the gas-generating unit. The usual time required for initial kindling of the fuel in the gas generator and starter motor is from 6 to 8 minutes. The time of kindling fuel in the gas generator is from 3 to 4 minutes, the remaining time is used in transferring the motor to gas.

The consumption of starting gasoline for one start is from 0.4 to 0.6 kilogram; for an hour's work of the tractor it is from 0.12 to 0.18 kilogram. The intake pipe of the blower is fitted with a valve closed during operation of the gas motor and opened only on kindling the fuel in the gas generator.

Owing to the vacuum created by the centrifugal blower during kindling, generated gas enters it and passes through the entire gas-generator unit.

The fuel in the gas generators is lighted by a pilot light.

The G-58 gas motor develops the planned horsepower on all four types of solid fuel at 1,400 revolutions per minute. The power of the motor using charcoal is considerably higher than on other fuels, which can be explained by the high calorific quality of the generator gas obtained from that fuel: for charcoal, 1,375 kilocalories per nominal cubic meter; for wood and peat briquettes, 1,100-1,250 kilocalories per nominal cubic meter.

To compare the power output of the G-58 and D-2G gas motors, they were tested with the same UG-2 gas generator operating on charcoal.

The tests revealed that at the normal 1,400 revolution per minute, the power output of the GD-50 motor is 59.3 horsepower, while that of the D-2G motor is 56 horsepower; the maximum power output in both cases was attained at 1,600 revolutions per minute.

The stability of the power output of the G-58 motor may be characterized as follows: after 1,200 hours of use in hauling loads, using gas generated from wooden logs it was 52.5 horsepower; from peat briquettes, 51.2 horsepower; and from charcoal, 57 horsepower.

The optimum angle of advance of the G-58 motor while using AS-180 spark plugs was set between 28-30 degrees before top dead center, while for the D-2G it was 37 degrees before top dead center using the same spark plugs. This indicates the superiority of the combustion chamber selected for the G-58 motor.

At present, gas-generator tractors produced on the basis of the DT-54 have undergone continuous testing. The experimental work of NATI also demonstrated the possibility of using semicoke, lignite, and anthracite fuels.

This permits the use of gas-generator tractors in many regions of our country for agriculture and other work. Owing to the negligible decrease in tractive power of the GB-58 and the tractive power of the GT-58 (equal to that of the DT-54), it is possible to use these tractors with the same trailer implements as with the DT-54.

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In productivity the gas generator tractors will produce only slightly less than the DT-54.

/Appended tables and figures follow./

Table 1. Horsepower Per Liter of Displacement of Motors Operating on Gas Generated From Wooden Logs

Type Tractor	Type Motor	Horsepower Per Liter of Displacement
ChTZ-SG60	SG-60	3.00
ChTZ-SG65	MG-17	3.88
SKhTZ-G58U	SKhTZ-1G	4.43
KhTZ-T2G	KhTZ-D2G	6.03
GB-58	G-58	6.70

Table 2. Tractive Force on the Drawbar While Working Stubble Fields (in kilograms)

Gear	DT-54	GB-58 and GT-58
First	2,919	2,810
Second	2,160	2,070
Third	1,788	1,700
Fourth	1,486	1,395
Fifth	1,003	920

Table 3. Results of Testing G-58 Motor After 1,200 Hours of Operation

Fuel	Moisture Content of Fuel (percent)	Horsepower	RPM	Specific Consumption of Fuel (liters/hp hr)
Hardwood	14.5	52.5	1,400	0.934
Softwood	7.4	51.8	1,400	0.826
Peat briquettes	11.5	51.2	1,400	0.970

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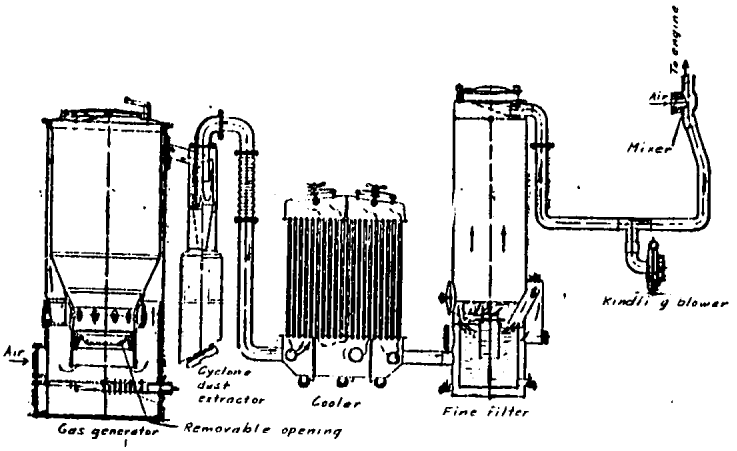

Figure 1. Gas Generator Unit of the GB-58 Tractor

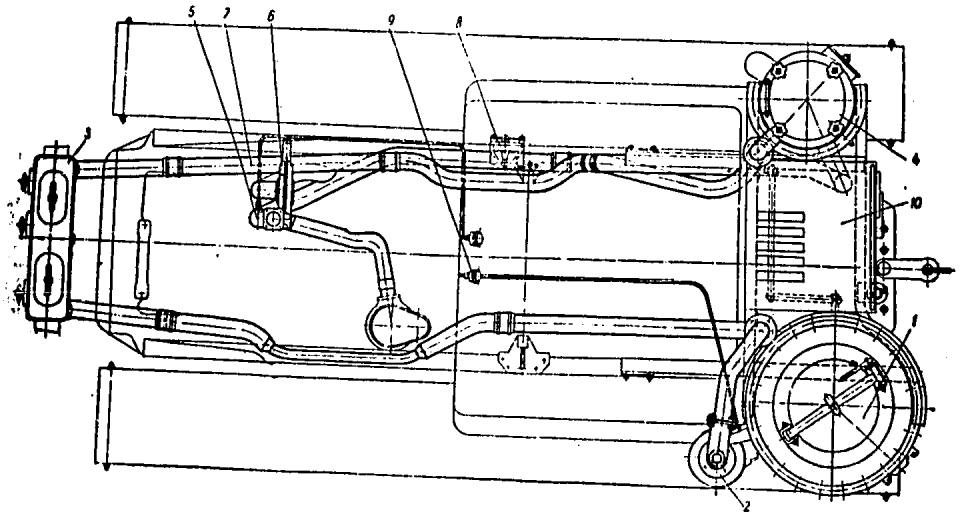

Figure 2. Location of Aggregates of the Gas-Generator Unit on the GB-58 Tractor

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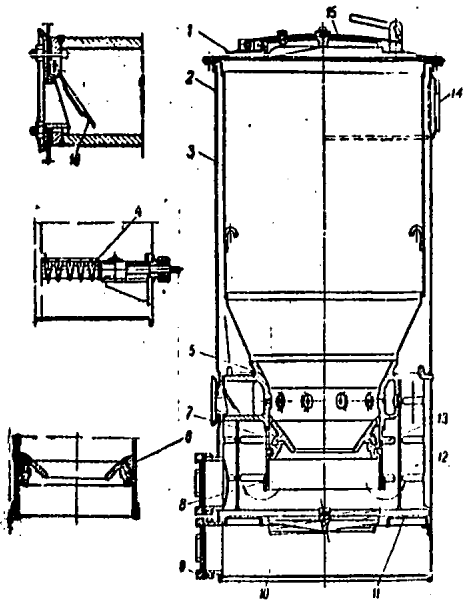

Figure 3. AG Gas Generator for Bituminous Fuels:
1. Hopper opening
2. Housing
3. Hopper
4. Grate
5. Air jacket
6. Opening for wooden logs
7. Opening for peat briquettes
8. Cylinder of chamber
9. Ash removal hatch
10. Ashpit
11. Side grate
12. Screen
13. Support ring
14. Gas take-off pipe
15. Loading hatch
16. Reverse valve

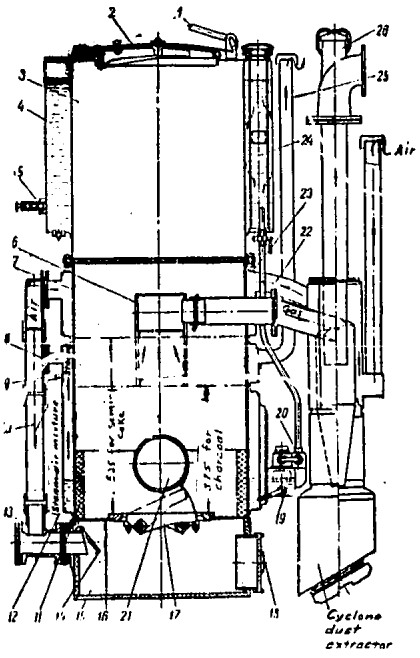

Figure 4. BG Gas Generator for Charcoal, Semicoke, and Anthracite:
1. Locking handle
2. Loading hatch
3. Hopper
4. Water tank
5. Pet cock
6. Gas take-off pipe
7. Housing
8. Steam metering diaphragm
9. Steam superheater
10. Pipe for steam-air mixture
11. Insulation
12. Vaporizing jacket
13. T-joint
14. Reverse valve
15. Ashpit
16. Supporting plate
17. Grate
18. Hatch
19. A floating water-level regulator
20. Settling tank
21. Hatch for removing slag
22. Connecting pipe
23. Air preheater
24. Water filter
25. Steam exhaust pipe
26. Gas exhaust pipe used when engine is stopped

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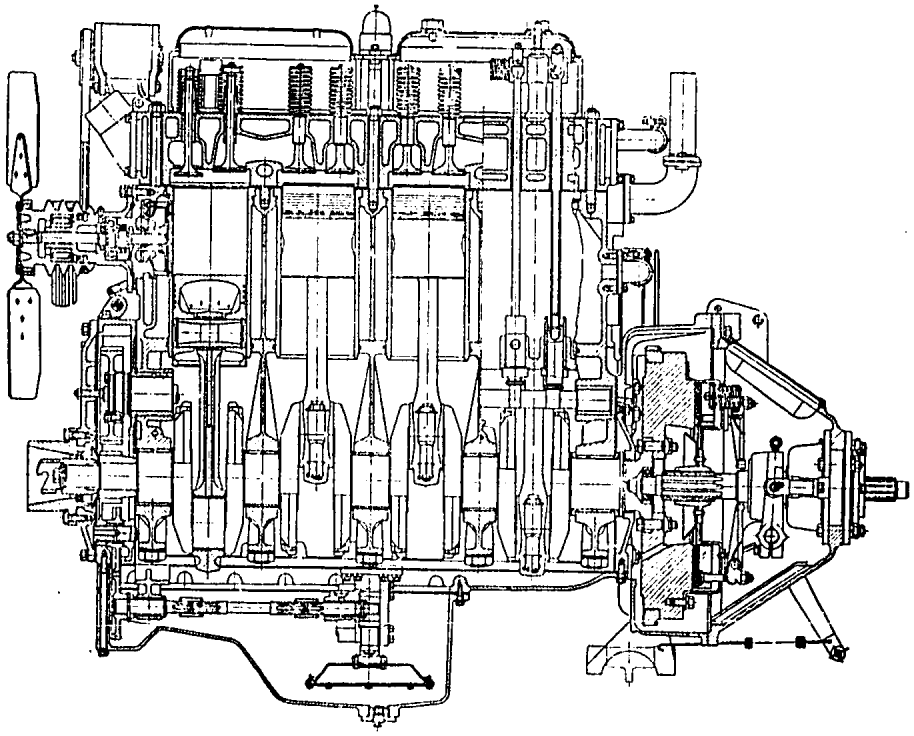

Figure 5. Longitudinal Section of the G-58 Gas Motor

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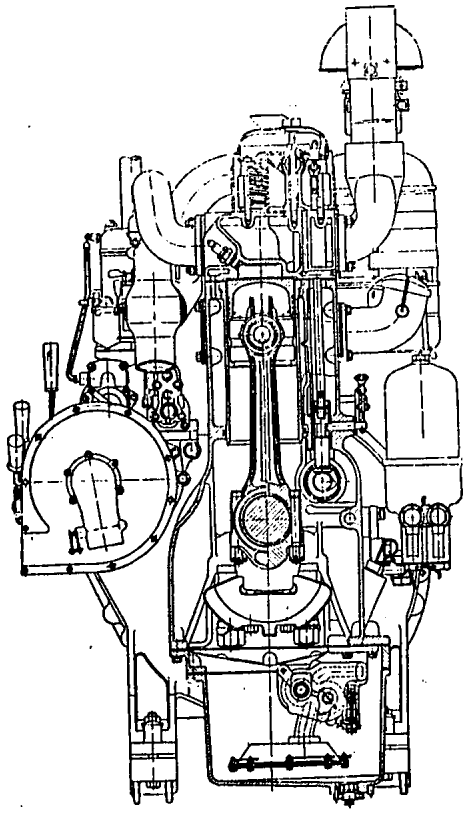

Figure 6. Cross Section of the G-58 Gas Motor

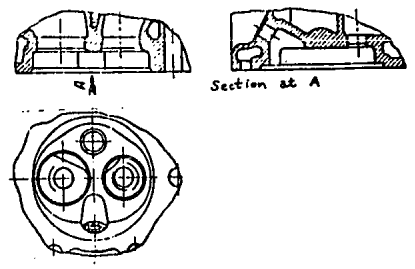

Figure 7. Sketch of the Combustion Chamber of the D-2G Motor

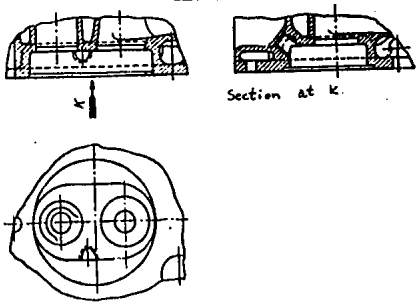

Figure 8. Sketch of the Combustion Chamber of the G-58 Motor

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